Exploring Substrate Effects on CVD Growth of MoS_2 for Technological Applications

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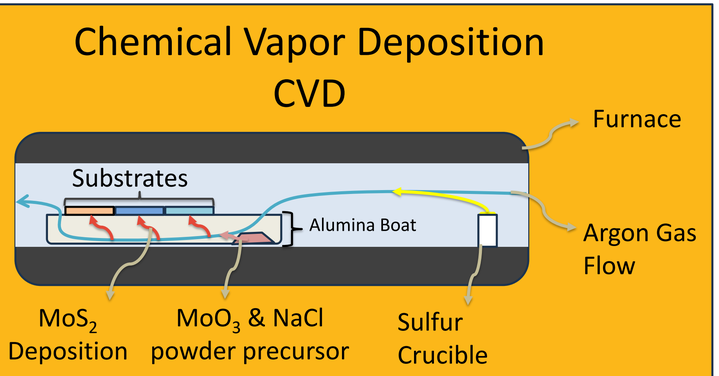
Abstract

This study investigates the impact of substrate type on the chemical vapor deposition (CVD) growth of 2D (monolayer) MoS_2, a leading material with transformative applications in electronics and energy storage. By optimizing thin film growth parameters for substrates like SiO2, Sapphire, and Fused Silica, the aim is to establish a baseline recipe for each substrate. This will provide other researchers general guidelines for quality thin film growth, facilitating advancements in MoS_2-based technologies such as ultra-thin transistors and batteries.

Method

Figure 1:
Transversal view of CVD process. In the right end there is an inflow of argon gas which carries the sublimated precursors and growth promoter (Sulfur, MoO_3, and NaCl). Then the flux deposits MoS_2 on the substrates which are rested on the alumina boat.



1 Gas Flow
One hundred sccm was the argon gas flow during the growth.

2 Precursors
Two precursors used, MoO_3 & Sulfur. In addition to the growth promoter of NaCl.

3 Substrates
Three substrates were used, SiO_2 , C-Cut Sapphire , and Fused Silica.

4 Key parameters
Four main parameters were analyzed which are precursor ratios, growth time, gas flow, and substrate positioning.

5 Growth time
A five-minute growth time was used for this study.

6 Precursor amount
Six mg of MoO_3 , and 0.4 mg of NaCl were used as powder precursors. The sulfur at the top of the crucible was sublimated, although not by a measured amount.

7 Growth temperature
Seven hundred and eighty degrees Celsius (780°C), was the growth temperature used for this study.

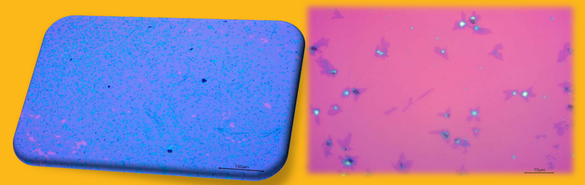
Conclusions

	Grow MoS_2?	Grow MoS_2 thin film?	Grow MoS_2 monolayer?	Grow high quality consistent MoS_2 monolayer film?
SiO_2	✓	✓	✓	
Fused Silica	✓		✓	
Sapphire	✓	✓	✓	✓

Parameters like MoO_3-NaCl ratio and substrate positioning were crucial in fine tuning MoS_2 growth.

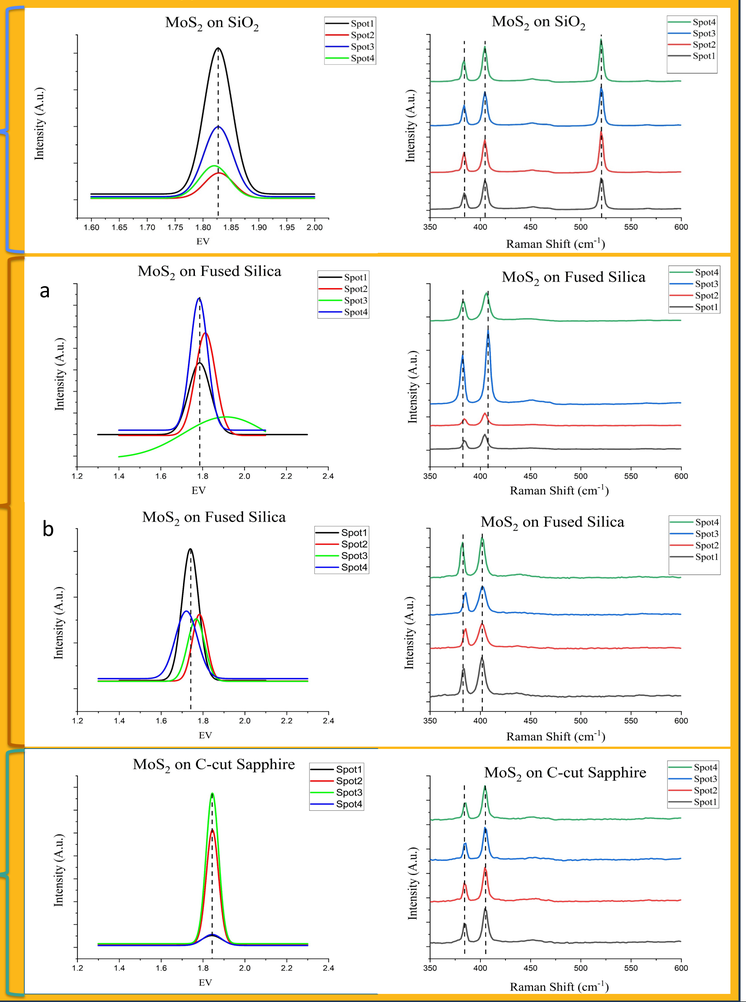
Results

Figure 2: Optical images of growths on different substrates, in order of SiO_2, Fused silica, and then Sapphire. 10x magnification on the left and 100x magnification on the right.



Note: Fused silica has two sets of images and graphs because thin film growth was unsuccessful, and result **a** & **b** represent the two closest results to a thin film that was possible in this study for that substrate type.

Figure 3: Characterization of growths, with Photoluminescence measurement on the left and Raman spectra on the right. These characterizations were done on 4 spots spread across the entire sample. The results are presented in order of SiO_2, Fused silica, and then Sapphire



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